Quiz 1 - Take Home (Solution Set)

Open Notes and Internet

Instructor: A.A. Trani

Instructions

Create a solution file using the word processor of your choice. Convert to PDF and submit to Canvas. **Include all screen captures of all your work including aircraft manufacturer's tables and figures, FAA nomographs and others if you want to receive partial credit**.

Honor Code Pledge

The information provided in this exam is my own work. I have not received information from another person while doing this exam.

_____ (your signature/name)

Problem 1 (35 points)

Perform an assessment of the runway length at White Plains Westchester County Airport (HPN).A new airline would like to operate from HPN using the Boeing 737-8 (Boeing 737-8 Max) with characteristics shown in Table 1. For this analysis, use the latest version of the Boeing documents for airport design.

Figure 1. *Aircraft Considered in the Runway Length Analysis of HPN. Picture Source: A.A. Trani. Boeing 737-9 (Max) with CFM LEAP-1B engines. Aircraft maximum design takeoff weight is 189,900 lbs. and 193 seats in a two-class layout.*

White Plains Airport (HPN) information from Arnav.

Runway	Information
16/34	**6549 x 150 ft. / 1996 x 46 m (0.9% slope)**
11/29	4451 x 150 ft. / 1357 x 46 m
Note	59 foot difference in elevation between thresholds 16 and 34
Airport elevation	439 feet
Temperature (hottest month of the year)	84.0 deg. Fahrenheit (historical) **86.4 deg. F. with higher emissions**
Standard temperature at 439 feet	57.4 deg. F.
Delta temperature at HPN (deg. F)	**29 (86.4−57.4)**
Use ISA + 27 deg. F. Charts	29 deg. F is within 3 deg. F of 27 deg. F.

a) Estimate the operating empty weight of the aircraft using the payload-range diagram.

OEW ~ 104,000 lbs using the lowest value of the payload-range diagram.

b) Can the Boeing 737-9 Max operate from HPN in routes to Denver (DEN) and Santo Domingo, Dominican Republic (SDQ) with 100% of the seats full at the airport design temperature? Show me all the steps in the analysis to estimate runway length for the critical route. Clearly state al your assumptions and show your intermediate calculations. In your analysis consider future climate change temperature effects (i.e., higher emissions). Also, consider the runway grade in your analysis.

HPN to DEN great circle distance is 1,412 nm (1,497 nm with 6% detour)

HPN to SDQ great circle distance is 1,371 nm (1,453 nm with 6% detour).

The critical route is HPN to Denver (1,497 nm typically flown).

Weight of 193 passengers is 42,460 lbs. (at 220 lbs per passenger). To cover 1,500 nm, the aircraft has a Desired Takeoff Weight (DTW) of 170,000 lbs (see Figure 2).

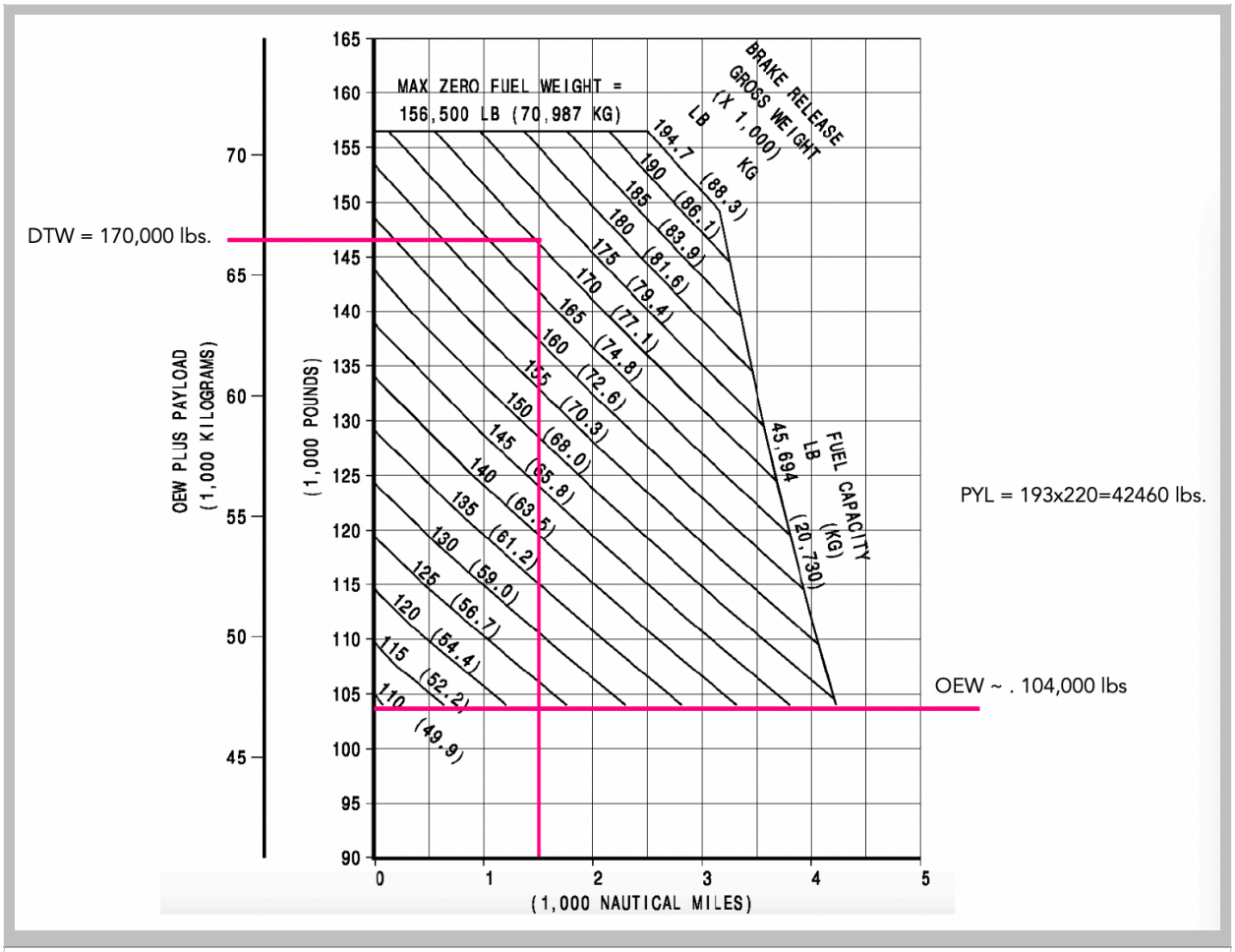

Figure 2. Boeing 737-9Max Payload-Range Diagram.

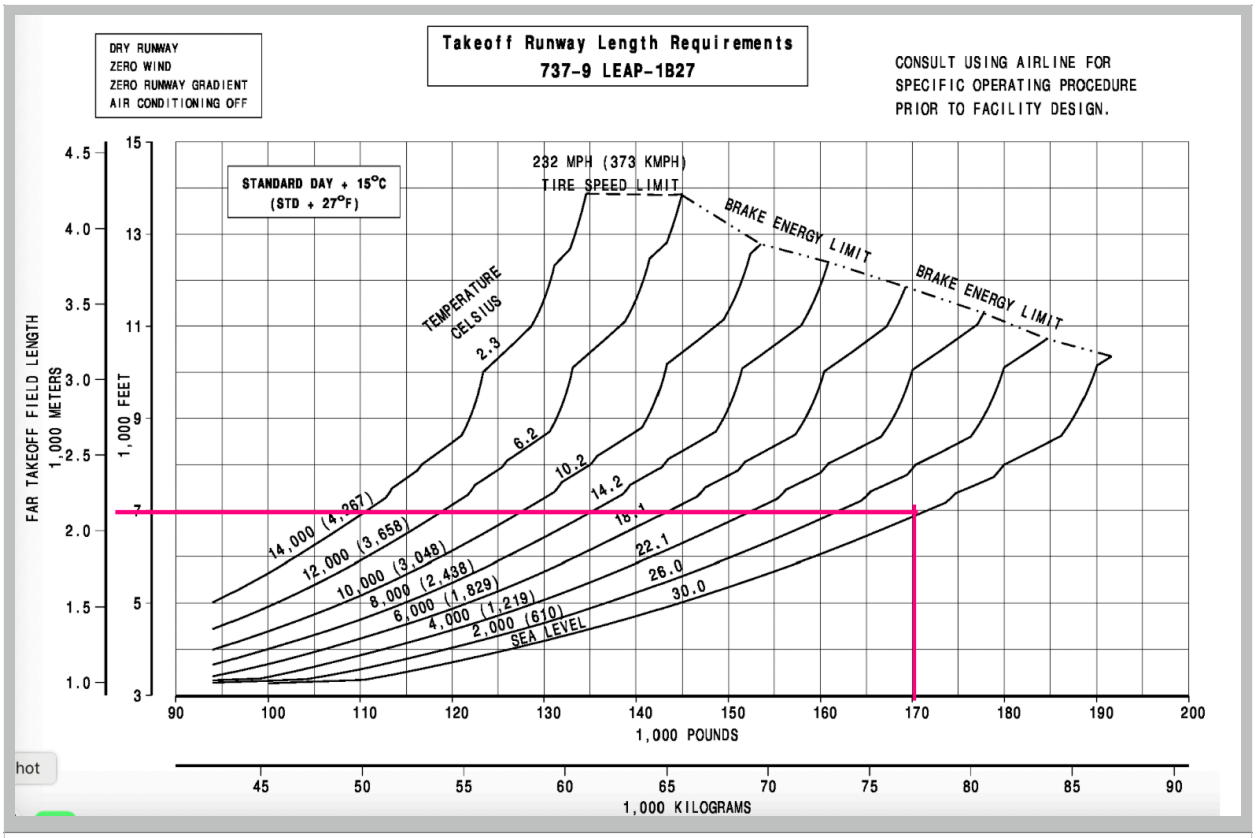

Figure 3. Boeing 737-9Max Takeoff Field Length Chart. ISA +27 deg. F. Takeoff Field required is 7,000 feet Uncorrected for Runway Grade.

Takeoff Field Length required:

Use the Boeing data for ISA + 27 deg. Fahrenheit (see Figure 3) to obtain a takeoff field length of 7,000 feet (uncorrected for grade).

Runway length adjustment for runway grade:

Increase 10 feet for every 1-foot in elevation difference between minimum and maximum centerline elevations.

The change in elevation between thresholds is 59 feet. Apply correction and increase the runway length by 590 feet.

Runway length required (corrected by grade) =7,000 + 590 = 7,590 feet (takeoff).

Runway length required for landing is 6,100 feet (use **wet pavement information and see Figure 4**). The analysis assumes maximum allowable landing weight because MALW is less than the Desired Takeoff Weight (DTW). The landing analysis uses the maximum flap setting for landing for the Boeing 737-9Max (40 degrees). The maximum flap setting provides the lowest landing runway length required.

Takeoff dominates and 7,590 feet of runway is needed to operate to DEN (the critical route). Note that both routes have very similar distances so the runway lengths for both are expected to be very close.

A runway extension of 1,040 feet will be needed to accommodate both flights.

No, the aircraft cannot operate the routes with the existing runway length.

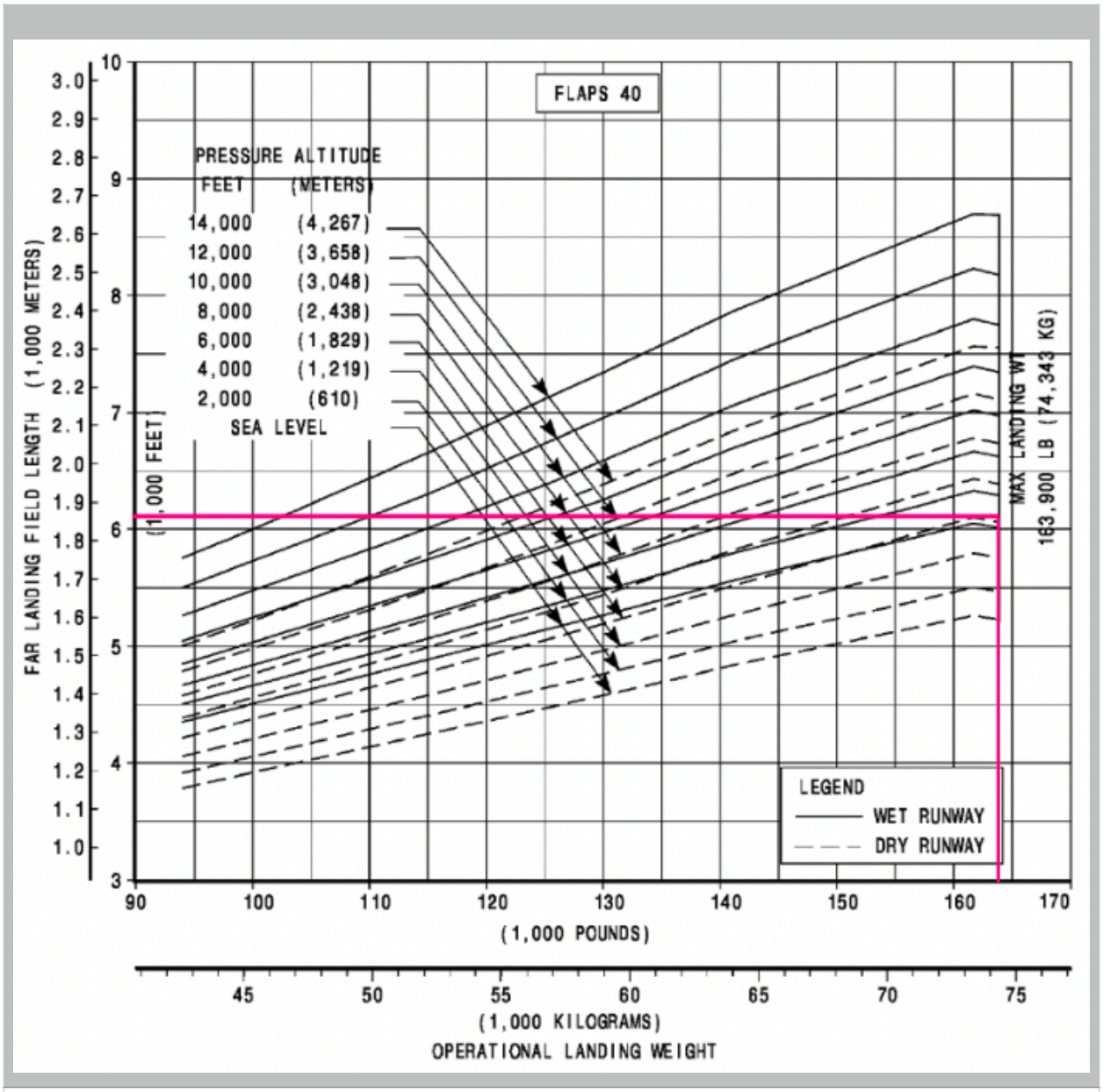

Figure 4. Boeing 737-9Max Landing Distance with 40 deg. Flap Setting. Landing Runway Length Required is 6,100 feet (wet pavement) at Maximum Allowable Landing Weight (MALW).

c) Use Google Maps or Google Earth to examine the runway ends for the longest runway at HPN. Tell me if the airport complies with the RSA and ROFA dimensions required. Assume the critical aircraft is the Boeing 737-9Max.

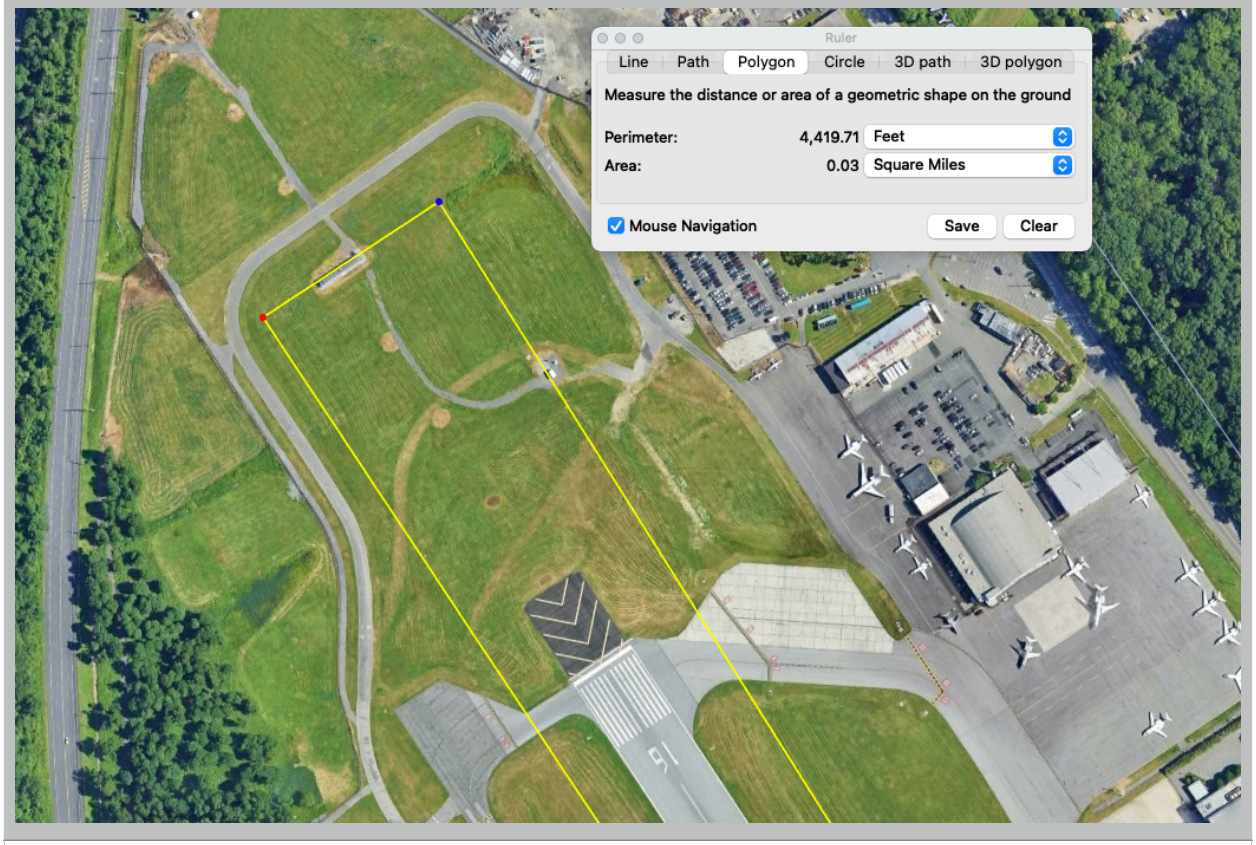

Figure 5. HPN Airport NW Side Runway 16 Threshold. ROFA and RSA are Protected. ROFA Shown in Yellow.

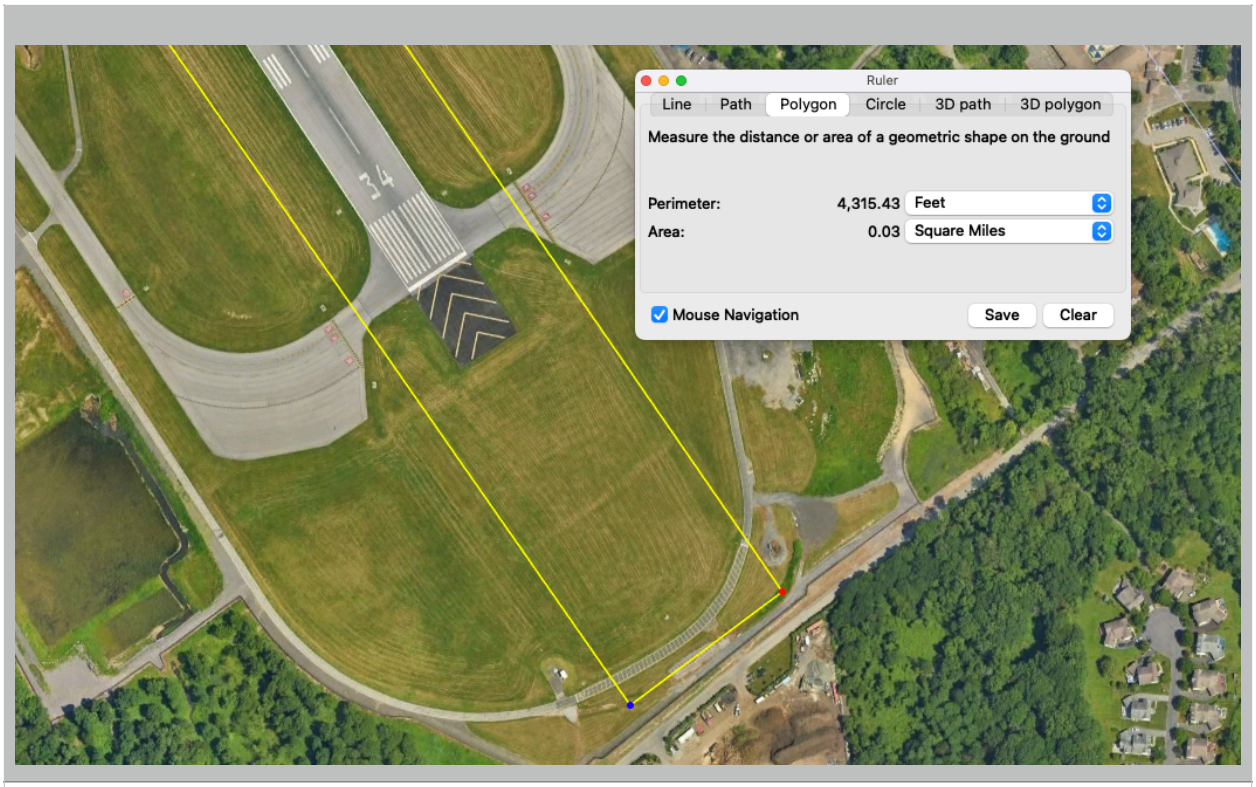

Figure 6. HPN Airport SE Side Runway 34 Threshold. ROFA and RSA are Protected. ROFA Shown in Yellow.

d) Estimate the runway length needed if the airline wants to fly the critical route with 100% passengers plus an additional 10,000 lbs. of cargo. Estimate if a runway extension is needed. If a runway extension is needed, would the runway extension fit in the existing airport property?

Adding 10,000 lbs of belly cargo increases the Desired Takeoff Weight (DTW) to 180,000 lbs. Figure 7 shows the uncorrected Takeoff Field Length as 8,200 feet. Adding the grade correction adds another 590 feet for a total of **8,790 feet. A very substantial increase in runway required compared to the solution obtained in parts (a) and (b).**

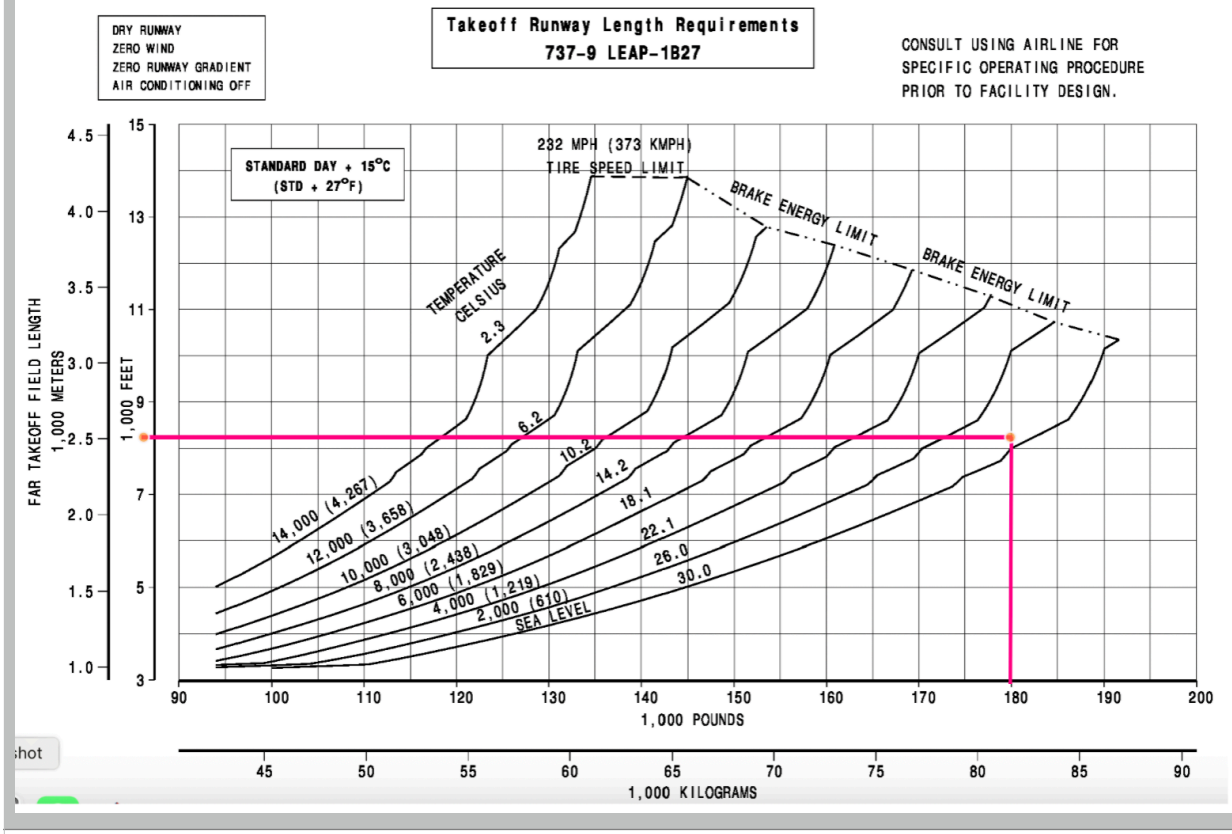

Figure 7. Boeing 737-9Max Takeoff Field Length Chart. ISA + 27 deg. F. Takeoff Field required for DTW 180,000 lbs is 8,200 feet Uncorrected for Runway Grade.

Problem 2 (35 Points)

Use the Small Aircraft Runway Length Analysis Tool (SARLAT) to evaluate the runway at Grant Co. Airport (SVC) in New Mexico. The airport serves single, multi-engine piston, turboprop and jet powered aircraft (see Table 1).

Table 1. Aircraft Fleet Mix for Problem 2.

Aircraft Type	Aircraft	Percent of Fleet Mix (%)
Piston	Cirrus SR20	20
Piston	Cessna 340	14
Piston	Beechcraft Baron 58	13
Turboprop	Beechcraft King Air B200GT	10
Turboprop	Beechcraft King Air B350ER (Advanced Air)	5
Turboprop	Cessna 208 Caravan	12
Jet	Cessna 560 XL	6
Jet	Cessna Citation 3	8
Jet	Embraer Phenom 300	12
Total		100

Grant Co. Airport (SVC) information from Arnav.

Runway	Information
8/26	**6803 x 100 ft. / 2074 x 30 m (0.14% slope)**
17/35	5473 x 75 ft. / 1668 x 23 m
12/30	4675 x 75 ft. / 1425 x 23 m
3/21	4537 x 80 ft. / 1383 x 24 m
Airport elevation	5446 feet
Temperature (hottest month of the year)	89.1 deg. Fahrenheit 91.7 deg. F. with higher emissions

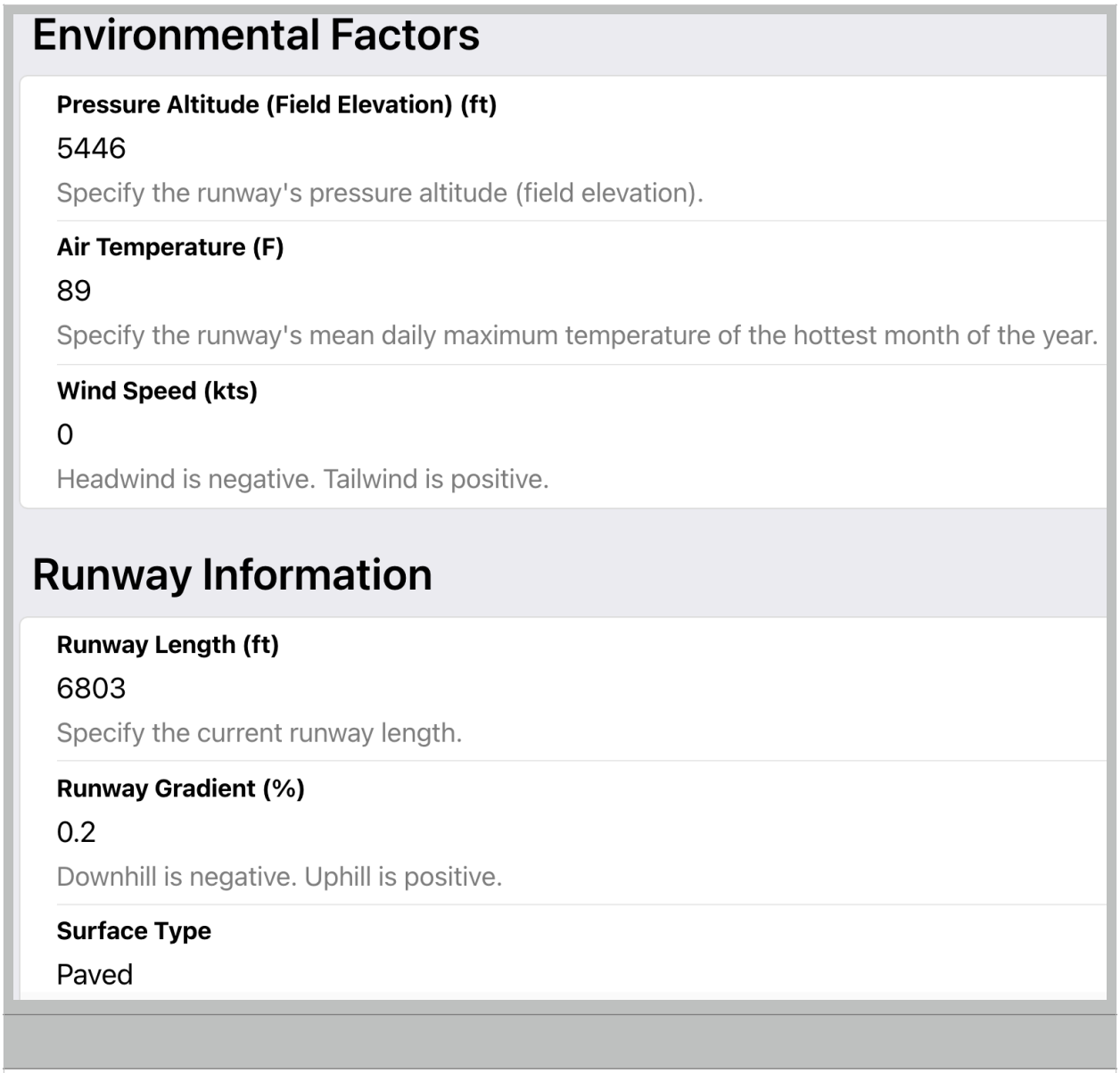

Figure 8. SARLAT Evaluation Case Input Parameters. The Evaluation Assumes Runway 8/26 is used for Departures and Landings.

a) Is the existing runway length available suitable for corporate jet and turboprop operations at 80% useful load when the runway pavement is wet? Explain.

No. Some aircraft like the Beechcraft King Air B350ER and the Phenom 300 **cannot operate at 80% useful load** at the New Mexico Airport. Operating under dry pavement conditions, the King Air B350ER is limited to 59% useful load (see Figure 8). Under dry pavement conditions, the Phenom 300 is limited to 75% useful load (see Figure 9).

Aircraft Name	Aircraft Mix	Takeoff Weight (Useful Load)		Landing at Maximum Landing Weight					
				No Correction		Part 135 Eligible		Part 135	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Piston									
Beechcraft 58 Baron	13%	5400 lbs 100 %	5400 lbs 100 %	✓	✓				
Cessna 340	14%	5990 lbs 100 %	5990 lbs 100 %	✓	✓				
Cirrus SR 20	20%	3150 lbs 100 %	3150 lbs 100 %	✓	✓				
Turboprop									
Beechcraft King Air 350ER	5%	14000 lbs 59 %	12451 lbs 34 %	✓	✓			✓	✓
Beechcraft King Air B200GT	10%	12500 lbs 100 %	12500 lbs 100 %	✓	✓			✓	✓
Cessna 208 Caravan	12%	8000 lbs 100 %	8000 lbs 100 %	✓	✓			✓	✓
Jet									
Cessna 560 XL	6%	19000 lbs 84 %	19000 lbs 84 %	✗	✗	✗	✗	✗	✗
Cessna CitationJet 3	8%	13870 lbs 100 %	13800 lbs 99 %	✓	✓	✓	✓	✓	✓
Phenom 300	12%	16400 lbs 75 %	16400 lbs 75 %	✗	✗	✗	✗	✗	✗

Figure 9. SARLAT Evaluation Case Solution. Individual Aircraft Results.

b) Name the most critical aircraft operating at the airport.

The Beechcraft King Air B350ER (a turboprop aircraft) and the Embraer Phenom 300 (a jet) are the most critical aircraft (from a runway performance viewpoint) operating at the airport.

c) The Beechcraft King Air B350ER operated by Advanced Air flies daily to Albuquerque, New Mexico. The aircraft has 10 seats. Determine if the flights can be operated with all seats full.

The great circle distance from SVC to ABQ (Albuquerque) is 188 statute miles (163 nm). The typical flown distance is 173 nm. The King Air B350ER departing SVC with a dry runway the aircraft carries 59% load. Figure 10 shows that for 59% useful load, the aircraft can carry 10 passengers, two pilots and fly 250 nautical miles (use linear interpolation between two values of distance: 200 and 300 nm). Technically, the SVC-ABQ trip is feasible.

However, considering higher emissions in the future, the King Air B350ER can only fly with 51% useful load from SVC (see Figure 12). Under those conditions, the flight from SVC to ABQ is not possible. The aircraft can only fly ~130 nm.

The Phenom 300 can operate from SVC with a 75% useful load (see Figure 9). The 75% useful load allows the Phenom 300 to fly eight passengers (plus two pilots) 535 nautical miles (using linear interpolation in Figure 11).

Mission Range (nm)	Maximum Number of Passengers	Useful Load (%)
100	10	50.4
150	10	53.5
200	10	56.4
300	10	61.5
600	10	73.7
1000	10	87.0
1316	10	97.4
1400	10	100.0
1500	9	100.0
1600	8	100.0
1700	7	100.0
1800	6	100.0
1900	5	100.0
2223	3	100.0

All values in the table assume two pilots and 30 lbs of luggage for each pilot

Figure 10. King Air B350ER Useful Load versus Mission Range Chart.

Mission Range (nm)	Maximum Number of Passengers	Useful Load (%)
100	8	47.4
150	8	51.9
200	8	55.9
300	8	63.1
600	8	78.3
1000	8	95.7
1247	8	100.0
1300	6	100.0
1400	5	100.0
1500	4	100.0
1600	3	100.0
1700	3	100.0
1800	2	100.0

All values in the table assume two pilots and 30 lbs of luggage for each pilot

Figure 11. Phenom 300 Useful Load versus Mission Range Chart.

d) If the operations are not possible with the existing runway, propose an improvement that the FAA will pay for.

No need for runway extension for the Beechcraft King Air B350ER to fly the SVC-ABQ route. However, a King Air B350ER is operated under a substantial useful load restriction from SVC under the existing conditions. The Phenom 300 aircraft is able to operate from the high elevation of the airfield with 75% useful load (8 passengers and fly 535

nm). The Phenom 300 could fly to Denver (DEN) or San Diego (SAN) from SVC carrying eight passengers and two pilots (typical distances flown by corporate jets).

Note that extending the runway say to 7500 feet, does produce an increase in the useful load for both Beechcraft King Air B350ER and the Phenom 300. Both aircraft are limited by useful load and temperature conditions.

Problem 3 (30 points)

Short answer.

	Question	Short Answer
1	Cuyahoga County airport has a EMAS able to stop a Gulfstream GIII traveling at 70 knots and overrunning the runway after landing on runway 6.	**False.** 290-foot EMAS GIII requires 435 feet for 70 knots.
2	The Bombardier Global Express 7000 taxiway design group.	**2B**
3	The Douglas DC-7B was a successful twin engine, piston-powered aircraft.	**False.** The DC-7B has four engines.
4	Runway 36C at Charlotte Airport (CLT) is a precision runway with approach lights.	**True** CLT runway 36C has a 2,400-foot long, high intensity approach lighting system with centerline sequenced flashers (called ALSF2).
5	Increase in RSA longitudinal dimensions when the airport transitions from B-II to C-II.	RSA and ROFA length increase from 600 to 1,000 feet
6	Maximum height of an object located 450 feet from the runway centerline. The critical aircraft is the Boeing 767-400 and the airport elevation is 1,250 feet. Only check the OFZ.	170.4-foot wingspan 1250 feet airport elevation Assume Category 1 **82.95 feet**
7	The AAC group for the Boeing 747-8.	D
8	Approach speeds used to designate AAC groups are measured at the minimum landing weight.	**False.** Approach speeds are referenced at maximum allowable landing weight.
9	Aircraft design group for the Airbus A350-1000.	**ADG V**
10	Number of commercial passengers that boarded flights at ROA in 2022.	296,000 passengers enplaned according to the BTS site
11	Largest airline carrying passengers at Reagan National Airport.	**American Airlines** (28% of passengers in 2022).

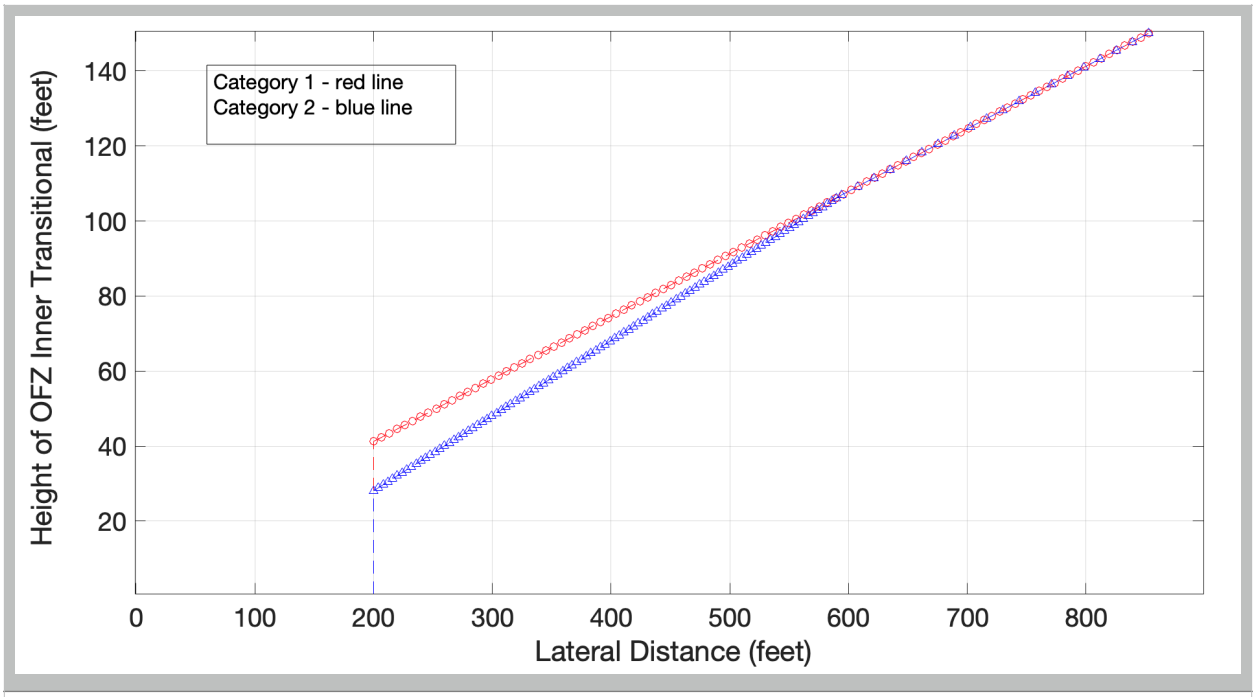

Figure 12. Inner-Transitional OFZ for Problem 3. Boeing 767-400 is the Critical Aircraft (170.34 foot wingspan). H for Category 1 is 41.2 feet. H for Category II is 28.1 feet.

Aircraft Name	Aircraft Mix	Takeoff Weight (Useful Load)	
		Dry	Wet
Piston			
Beechcraft 58 Baron	13%	5400 lbs 100 %	5400 lbs 100 %
Cessna 340	14%	5990 lbs 100 %	5990 lbs 100 %
Cirrus SR 20	20%	3150 lbs 100 %	3150 lbs 100 %
Turboprop			
Beechcraft King Air 350ER	5%	13500 lbs 51 %	12168 lbs 29 %
Beechcraft King Air B200GT	10%	12500 lbs 100 %	12500 lbs 100 %
Cessna 208 Caravan	12%	8000 lbs 100 %	8000 lbs 100 %
Jet			
Cessna 560 XL	6%	18500 lbs 77 %	18500 lbs 77 %
Cessna CitationJet 3	8%	13870 lbs 100 %	13580 lbs 94 %
Phenom 300	12%	15600 lbs 63 %	15600 lbs 63 %

Figure 13. SARLAT Evaluation Case Solution. Individual Aircraft Results. Higher Emissions Scenario